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**University Examinations 2014/2015**

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF COMPUTER SCIENCE

**CCS 3476: THEORY OF COMPUTING**

**DATE: APRIL 2015 TIME: 2 HOURS**

**INSTRUCTIONS:** *Answer question* ***one*** *and any other* ***two*** *questions*

**QUESTION ONE (30 MARKS)**

1. State the central questions in computation and complexity theories respectively

(3 Marks)

1. Give the transition function for the following machines
2. Finite automata (2 Marks)
3. Push down automata (3 Marks)
4. Turing machine (3 Marks)
5. What is the language generated by the grammar G=(V,T,P,S) where P={S->aSb, S->ab}

(3 Marks)

1. Define what is computational grammar and its significance in computer science ( 3 Marks)
2. You just got hired by Kituku, the hottest software company of the 2014s. The company usually solicits applications from developers that it then sells in its Kituku Store. But some of these developers are very clumsy and their applications tend to crash. Your new boss has requested you to write a program called crash detector, which looks at the code of an application figures out if the application will ever crash. Is the program feasible or not justify your answer (3 Marks)
3. Given the by use of string a \*b+c prove this CFG is ambiguous (4 Marks)
4. Given  be an alphabet and let be a language and w as a string over the alphabet, when do we say A is decidable (3 Marks)
5. Given a string w to be consumed by Turing machine M, define the complexity of the TM (3 Marks)

**QUESTION TWO (20 MARKS)**

1. Explain whether the language accepted by a PDA by empty stack and final states are different languages (2 Marks)
2. What is the difference between Turing machine and push down automata in terms of memory (2 Marks)
3. Name and explain the two operation of PDA memory (2 Marks)
4. Consider the grammar below and generate a PDA (4 Marks)



1. Design a PDA that accept simple mathematical expression such as provided by the strings below  (10 Marks)

**QUESTION THREE (20 MARKS)**

1. Using mathematical model define what is context free grammar (3 Marks)
2. Let G= (V,S,R,S) be the context-free grammar, where V={A,B,S}, S={a,b}. S is the start variable, and R consists of the rules



Prove that ababba  (5 Marks)

1. Generate the production rules for the grammar for the language where  (5 Marks)
2. Context-free grammars are sometimes used to model natural languages. Consider the following English sentences and use them to answer the question below.

The girl is pretty

The girl that the boy likes is pretty

The girl that the boy that the clerk pushed likes is pretty

The girl that the boy that the clerk that the girl knows pushed likes is pretty

This is a special type of sentence built from a subject (The girl), a relative pronoun (that) followed by another sentence, a verb (is) and an adjective (pretty). Give a context-free grammar G that models this special type of sentence. Your terminal should be words or sequences of words like pretty or the girl (7 Marks)

**QUESTION FOUR (20 MARKS)**

1. Define Turing machine (2 Marks)
2. The Church-Turing Thesis claims that Turing Machines are a universal model of computation, any computation that can be performed on any computer we will ever build can also be done on a Turing Machine. Suppose I want to know what the smallest country in the world is. In real life, I would use Google, type in “smallest county”, and I get out the answer after a few clicks. But is cannot do this on a Turing Machine. How do I even connect a Turing Machine to the internet? Since there are computations we can do in real life but not on a Turing Machine, does this make the Church-Turing thesis is false, justify your answer (4 Marks)
3. Design a Turing Machine that halts on all inputs and accepts the languages

{x{a,b}\*|na(x)nb(x)}

Assume that the Turing Machine tape starts with a blank which is followed by the input

(12 Marks)

1. Explain how the Turing Machine solve the problem state in previous section (2 Marks)

**QUESTION FIVE (20 MARKS)**

1. In order to estimate the number of the left most derivation in a context free grammar so as to generate a string, it’s converted to Chomsky Normal Form (CNF)
2. What the upper bound of the left most derivation (2 Marks)
3. State the steps involved in the conversation (2 Marks)
4. State the general format of production in C.N.F (2 Marks)
5. Consider the grammar below and convert it to C.N.F (14 Marks)

